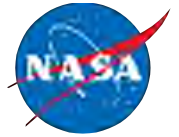




Airspace Systems Program

- NextGen Concepts and Technology Development (CTD) Project**
- NextGen Systems Analysis, Integration, and Evaluation (SAIE) Project**

Air Transportation Needs, Research and Transition



Needs

On-time arrival/departure
(schedule integrity)
Reduce operator costs
(fuel)
Increase system
productivity (aircraft/
operator)
Minimize impact on
environment
Design for scalability
Safety
Predictability

Challenges

Weather uncertainty
Human workload limits
capacity, throughput,
and precision delivery
Interactions: arrivals,
departures, and surface;
and metroplex
Prediction uncertainty
(trajectory, aircraft count,
aircraft location)
Mixed equipage
Trade-off between
environment and
capacity/throughput

Research Threads

- ! Conflict detection and resolution and analysis
- ! Functional allocation
- ! Safety assessment
- ! Arrival operations (integrated scheduling, sequencing, and merging and spacing)
- ! Integrated arrival/ departure operations
- ! Surface operations optimization
- ! Modeling, simulation and optimization techniques to minimize total delay
- ! Decision-making under uncertainty (weather integration)
- ! Capacity management
- ! Trajectory requirements
- ! Trajectory uncertainty prediction
- ! Trajectory interoperability
- ! Trajectory validation
- ! System level impact assessment
- ! Interactions between key research focus area

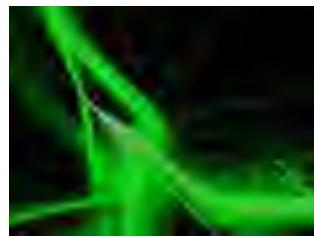
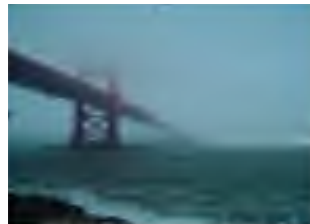
Research Focus Area

NextGen Concepts and Technology Development Project

Separation Assurance
Super Density Operations
Traffic Flow Management
Dynamic Airspace Configuration
Safe and Efficient Surface Operations

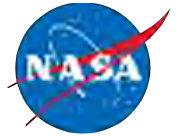
NextGen Systems Analysis, Integration, and Evaluation Project

Integration, Evaluation, and Transition
Interoperability Research
System and Portfolio Analysis



Domain and operations are complex and require sustained R&D to address challenges. NASA has the skills and experience to change the airspace system.

Airspace System Program (ASP) Objectives and Projects



Perform research to enable new aircraft system capabilities and air traffic technology to increase the capacity and mobility of the nation's air transportation system.

Integrate these capabilities to maximize operational throughput, predictability, efficiency, flexibility, and access into the airspace system while maintaining safety and environmental protection.



Projects

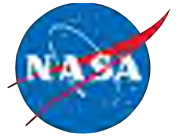
- ! **NextGen Concept and Technology Development (CTD) Project:**

Develop gate-to-gate concepts and technologies for NextGen to enable significant increases in capacity and efficiency

- ! **NextGen Systems Analysis, Integration, Evaluation (SAIE) Project:**

Facilitates R&D maturation of integrated concepts and technologies through evaluation in relevant environments, enabling transition to stakeholders

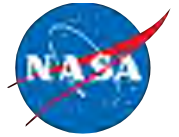
SAIE and CTD work together to cover foundational research to integrated capabilities



NextGen Concepts and Technology Development Project

**Develop gate-to-gate concepts and
technologies towards NextGen to enable
significant increases in capacity and efficiency**

Research Focus Area: Separation Assurance (SA)



Problem

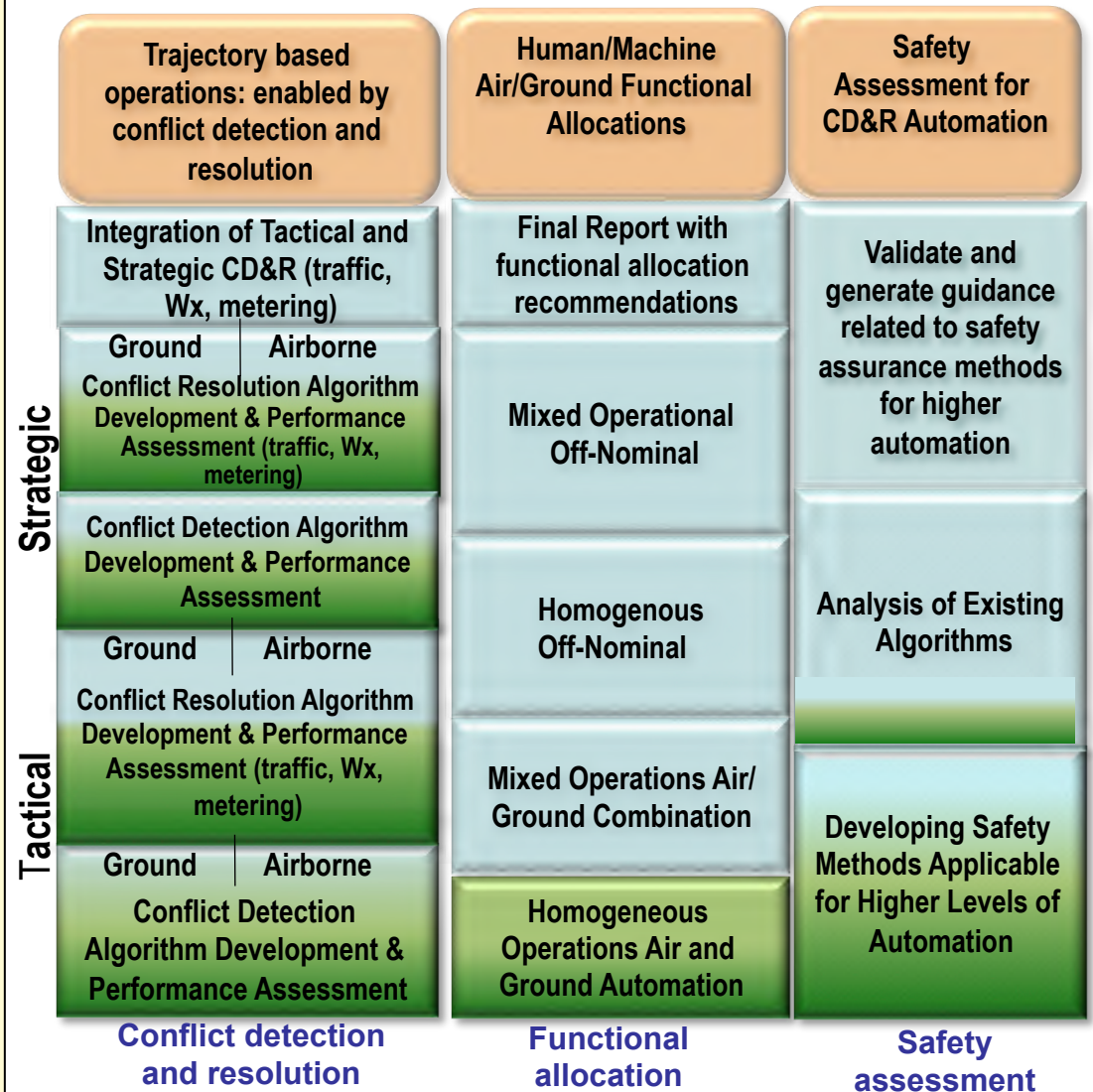
- ! Human controller workload and uncertainty limits airspace efficiency and capacity
- ! Sector-based solutions and mixed equipage

Research Being Pursued

- ! Automation and operating concepts for separation, metering, and weather avoidance in en route and transition airspace (airborne and ground-based)
- ! Concepts/algorithms for higher levels of separation assurance automation
- ! Efficient trajectories into capacity constrained airspace
- ! Separation assurance and collision avoidance algorithm compatibility

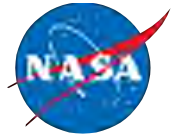
Partners: FAA, Lockheed Martin, Boeing, NRAs (MIT, Purdue, SJSU, Stanford, California State University-Long Beach, SAIC, LMI, and others)

Major Research Threads



Increase productivity, safety, and scalability

Research Focus Area: Super Density Operations (SDO)



Problem

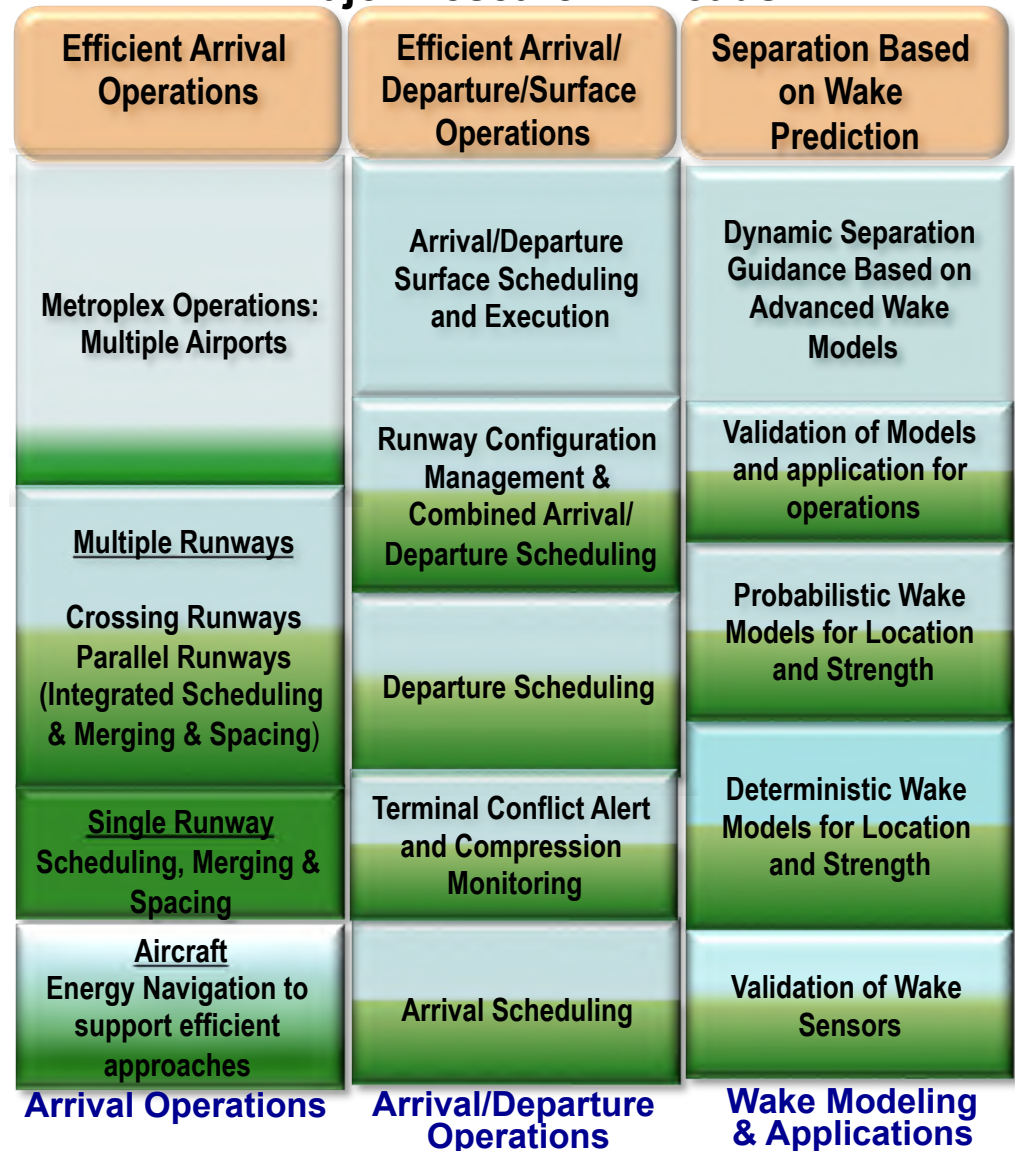
- ! Human control of spacing, merging, and separation assurance limits the capacity of the terminal airspace
- ! Mixed equipage must be safely managed
- ! Interactions between arrivals and departures

Research Being Pursued

- ! Algorithms that simultaneously solve/optimize the sequencing, merging, de-confliction and spacing
- ! Regional resource utilization or metroplex operations
- ! Closely spaced parallel runways

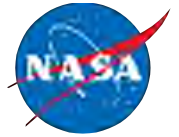
Partners: FAA, UPS, MITRE, ACSS, NRAs (MIT, Purdue, Metron, GA Tech, SJSU, Mosaic ATM)

Major Research Threads



On-time arrival/departure, reduce costs, impact on environment, safety and scalability

Research Focus Area: Traffic Flow Management (TFM)



Problem

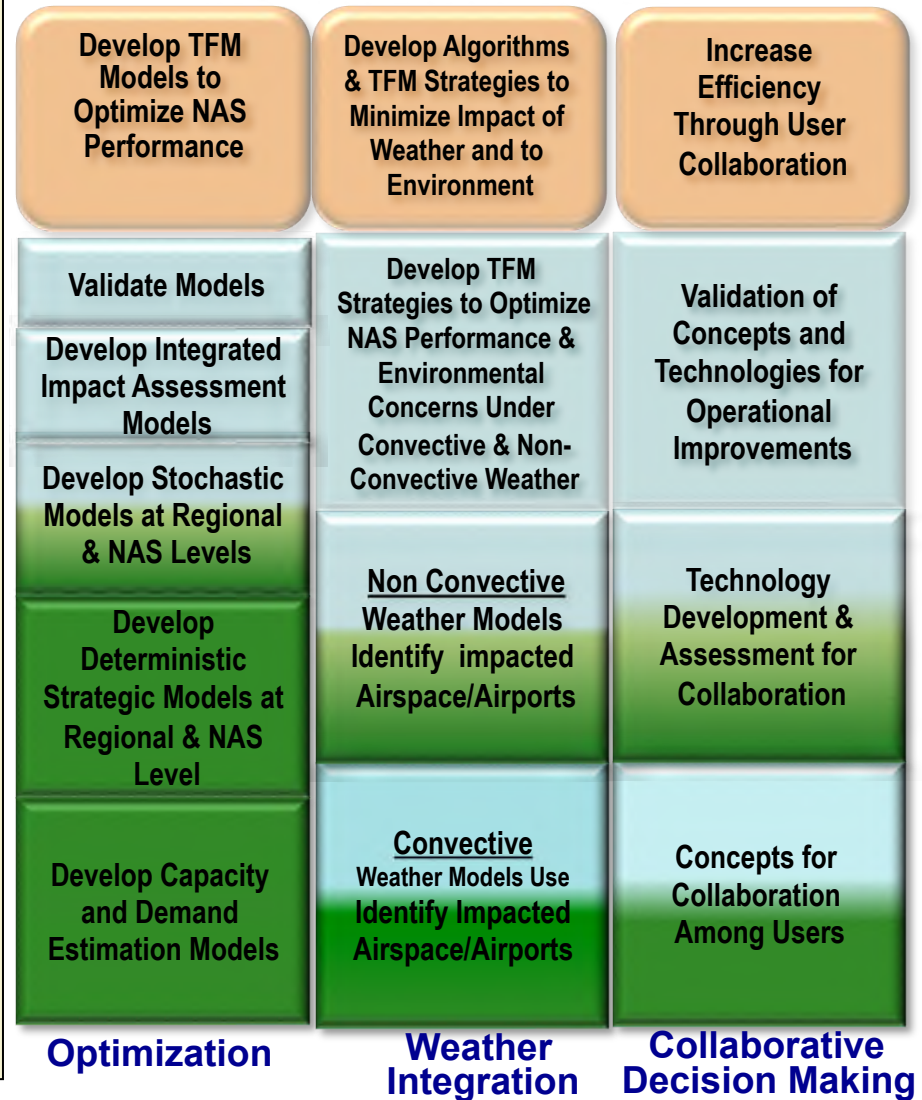
- ! Planning involves multiple time scales (local, regional, and national)
- ! Multiple decision with different goals (pilots, dispatchers, Air Traffic Service Providers (ATSP) flow managers)
- ! Decision making under uncertainty (e.g., weather)

Research Being Pursued

- ! Optimization methods for advanced flow management
- ! Probabilistic methods to address system uncertainties
- ! Weather Translation
- ! Collaborative Traffic Flow Management

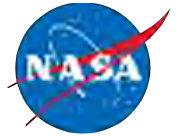
Partners: Mosaic, U.C. Berkeley, GA Tech, Virginia Tech, Univ. Maryland, MIT-LL, Engility Corp, and Washington State University

Major Research Threads



Demand/capacity imbalance with demand management

Research Focus Area: Dynamic Airspace Configuration (DAC)



Major Research Threads

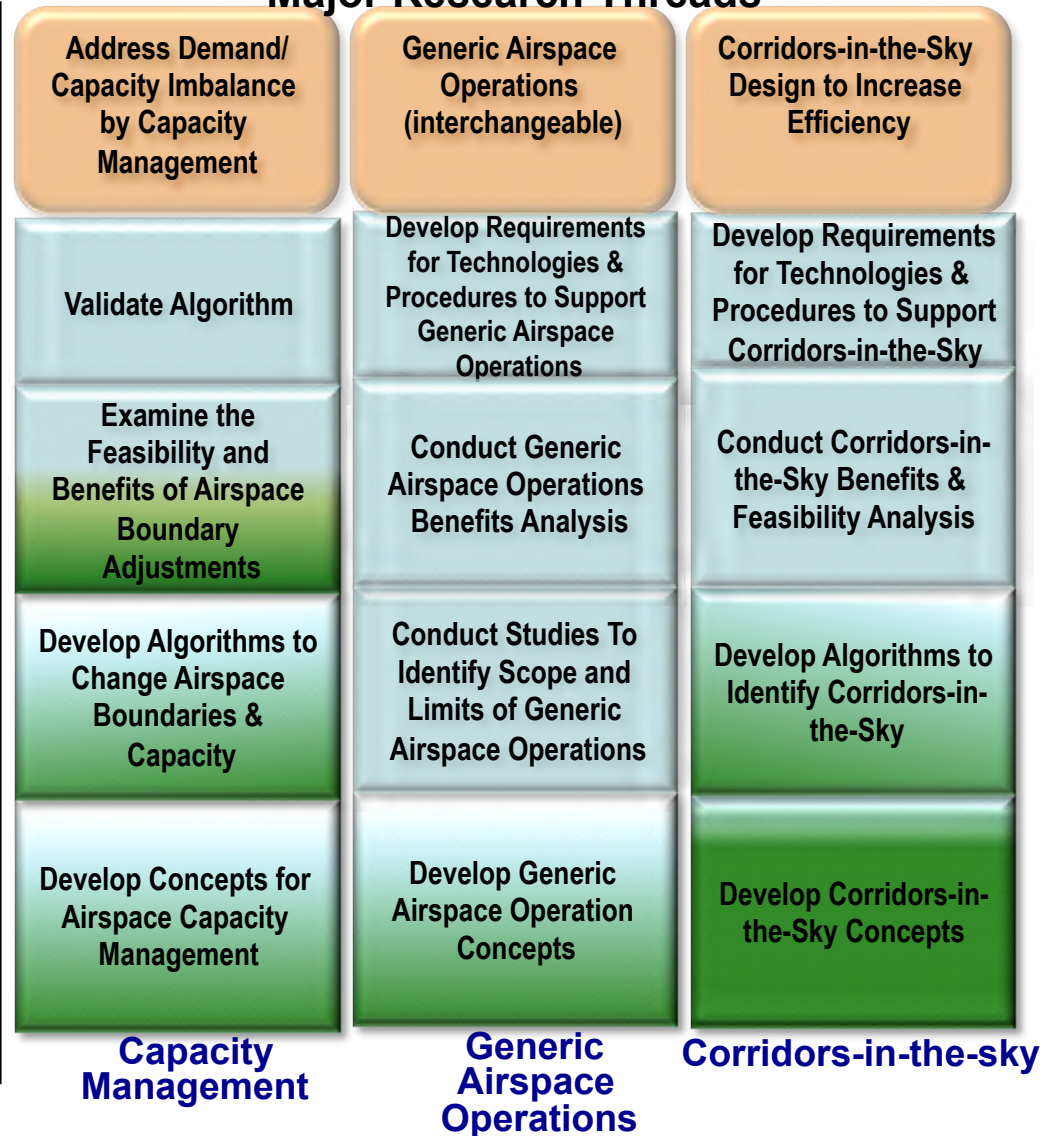
Problem

- ! Limited degrees of freedom for airspace changes (e.g., combine two adjoining sectors) and controller interchangeability
- ! Substantial time to modify airspace (years) and train controllers (months)

Research Being Pursued

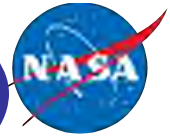
- ! Structure of the airspace (e.g., corridors-in-the-sky)
- ! Algorithms for airspace configurations - benefits and feasibility considerations
- ! Generic airspace

Partners: FAA, NRAs (Metron, Mosaic ATM, CSSI)



Demand/capacity imbalance addressed by resources and capacity management

Research Focus Area: Safe and Efficient Surface Operations (SESO)



Problem

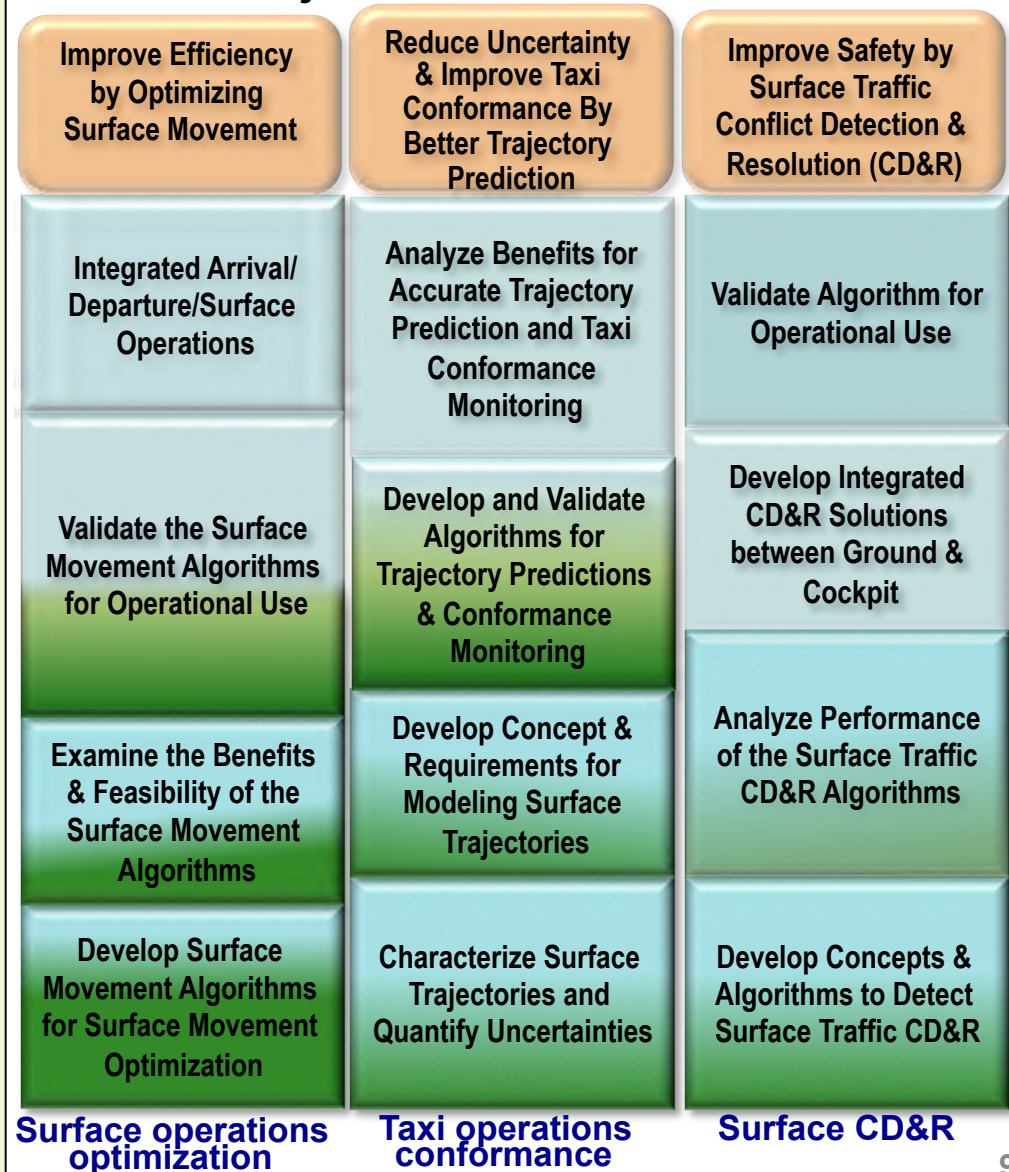
- ! Surface operations become inefficient under high density operations
- ! Static procedures limit flexibility, efficiency, and cause imbalance in runway loads
- ! Human workload may limit accommodation of expected future surface capacity growth

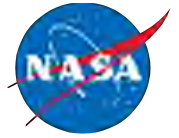
Research Being Pursued

- ! Concepts, algorithms, experiments, and analysis for surface traffic optimization
- ! Algorithms, analysis, and experiments for surface trajectory prediction and taxi conformance monitoring
- ! Concepts, algorithms, analysis and experiments for aircraft- and ground-based surface/low altitude conflict detection and resolution

Partners: FAA, NRAs (Mosaic ATM, Metron, Georgia Tech)

Major Research Threads

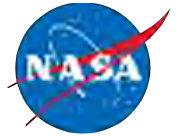




NextGen Systems Analysis, Integration, and Evaluation

Develop integrated solutions and transition technologies to stakeholders

Research Focus Area Integration, Evaluation, & Transition (IET)



Problem

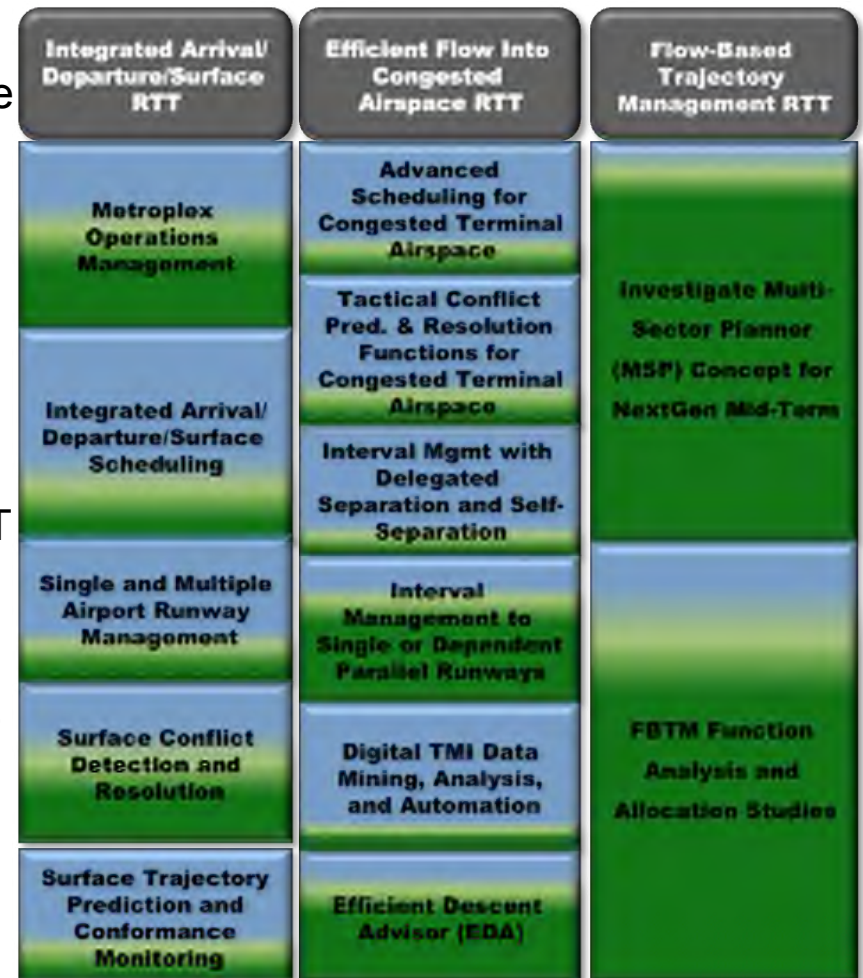
- ! Maturing foundational research requires additional efforts and integration of operational skill mixes to be teamed with researchers (“idea to implementation”)
- ! Transition of research concepts and technologies is more complex than handing a finished research product to a stakeholder

Research Threads

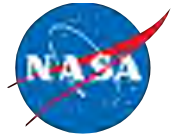
- ! Flow-Based Trajectory Management (FBTM) Research Transition Team (RTT)
- ! Efficient Flow Into Congested Airspace (EFICA) RTT
- ! Integrated Arrival/Departure/Surface (IADS) RTT

Research Being Pursued

- ! Multi-Sector Planner (MSP) requirements analysis – supports FBTM RTT
- ! Efficient Descent Advisor (EDA) simulations – supports EFICA RTT
- ! Interval Management – supports EFICA RTT
- ! Precision Departure Release Control (PDRC) – supports IADS RTT
- ! Airport surface optimization – supports IADS RTT



Research Focus Area Interoperability Research (IR)



Problem

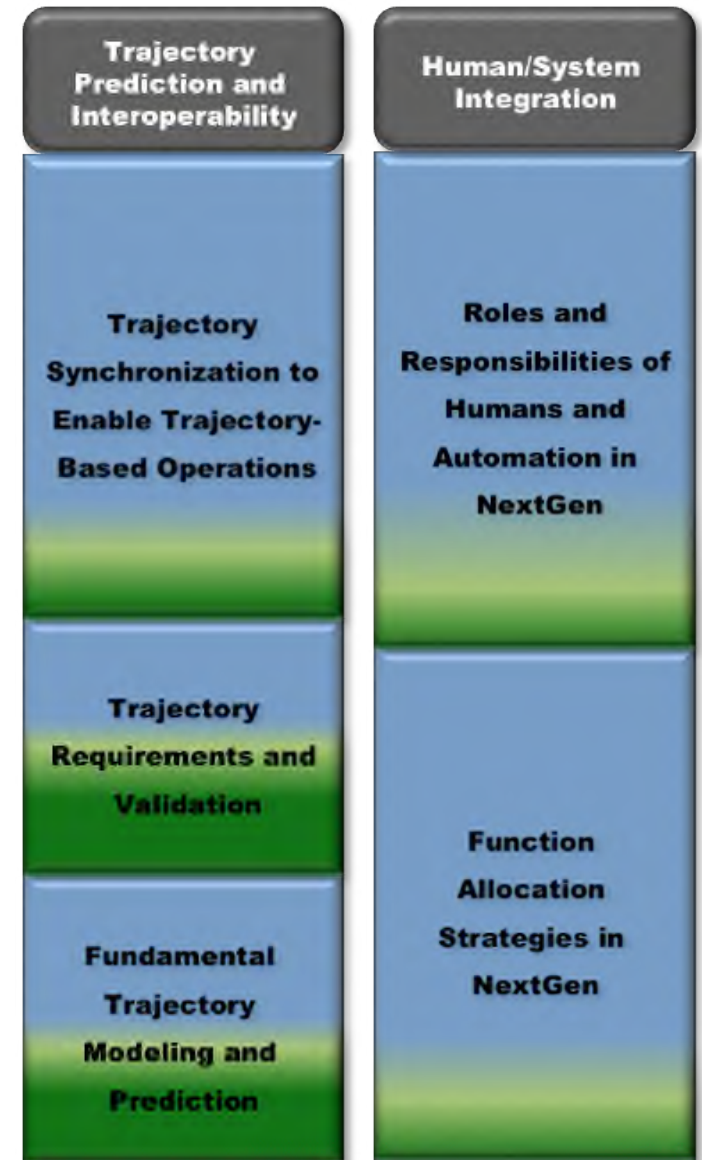
- ! Disparate flight and ground computers running trajectories created by various global stakeholders could create incompatible trajectory information
- ! Optimum allocation of roles between automation and humans unknown
- ! Optimum allocation of roles between air and ground automation unknown

Research Threads

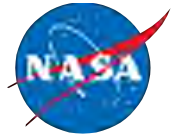
- ! Trajectory Prediction and Interoperability (TPI)
- ! Human/System Integration (HSI)

Research Being Pursued

- ! TP Requirements/Uncertainty/Validation
- ! New Trajectory Modeling and Prediction Capabilities
- ! Interoperability Across Multiple Systems
- ! Human/Automation Function Allocation in NextGen
 - Current focus: Tool Development, Tower Controllers (continuation of previous Airportal-funded research)



Research Focus Area System and Portfolio Analysis (SPA)



Problem

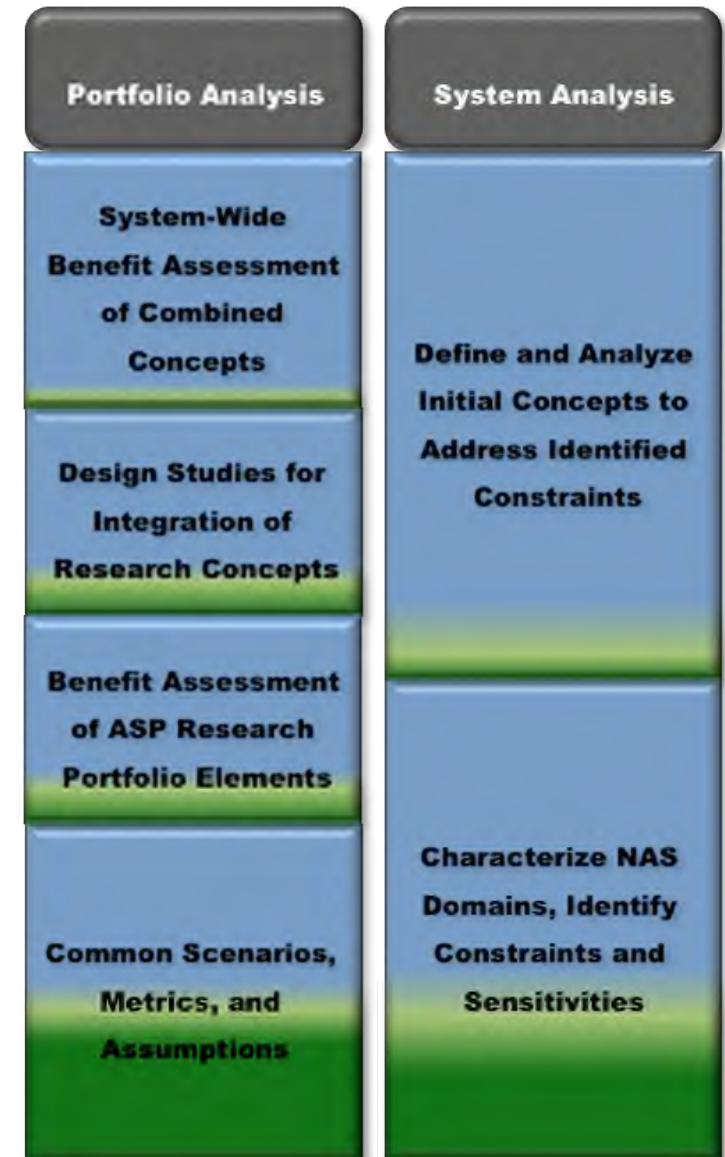
- ! Research is conducted on independent concepts and technologies in ASP portfolio and also needs to be analyzed with multiple concepts or at the system level for full benefits assessment
- ! The NAS is large and complex and the state-of-the-art knowledge must keep up as changes with new operations, operators, or operator behaviors continue to occur

Research Threads

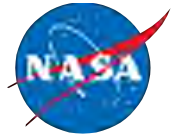
- ! Portfolio Analysis
- ! System Analysis

Research Being Pursued

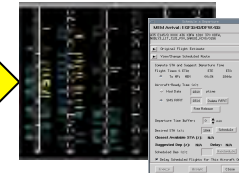
- ! Benefits Assessment of maturing R&D technologies
- ! Portfolio Analysis
- ! Integration Design Studies
- ! System Level Assessments
- ! Domain Characterization and Constraint Analysis



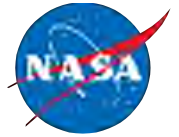
Research Transition Teams



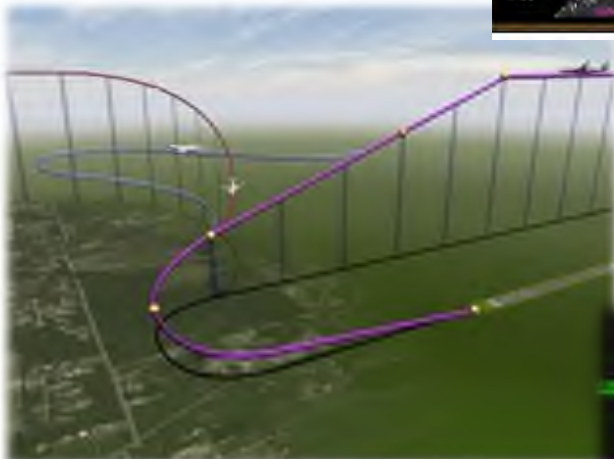
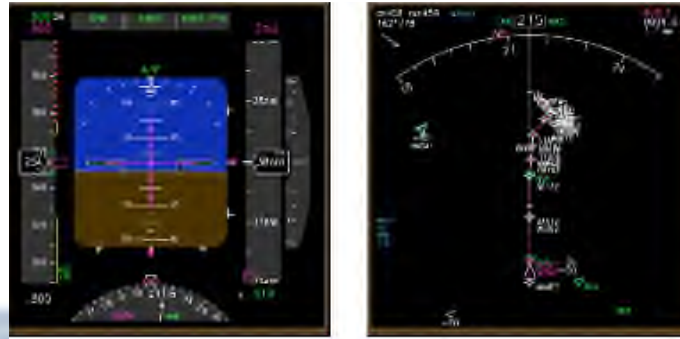
- ! **Efficient Flow into Congested Airspace:** Joint collaboration with industry partners for near-term efficient and reduced environmental impact of arrival operations under constrained airspace conditions.
 - ! TFM (digital Traffic Management Initiatives) analysis
 - ! Time-based flow management
 - ! Merging and spacing (work with ATO-P and SBS office)
 - ! Efficient Descent Advisor (Human in the Loop simulations and Flight Trial data collection)
- ! **Integrated Arrival/Departure/Surface:** Develop system-level concepts to efficiently manage NextGen arrival/departure/surface operations for the mid-term.
 - ! Precision Departure Release Capability
 - ! Tactical Runway Configuration Management
 - ! NASA's NTX testbed coordination with FAA testbed
- ! **Flow-Based Trajectory Management:** Identifying the feasibility and benefits of a multi-sector planner position and associated planning tools.
- ! **Dynamic Airspace Configuration:** Develop far-term concept for efficient partitioning of airspace and allocation of resources to meet NextGen capacity needs.



Notional Integration of Technologies



Flight Deck Precision Spacing



Efficient Arrival Procedures



Controller Spacing Tools



Advanced Scheduling Methods

